OCR
RECOGNISING ACHIEVEMENT

SPECIMEN

General Certificate of Secondary Education

A514/02

Design and Technology:
Innovator Suite
Control Systems: Pneumatics

Unit A514: Technical aspects of designing and making

Specimen Paper

Time: 1 hour 15 minutes

Candidates answer on the question paper.
Additional materials:

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each answer carefully and make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do not write in the bar codes.
- Do not write outside the box bordering each page.
- Write your answer to each question in the space provided.

INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 60.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
TOTAL	

This document consists of **12** printed pages.

[Turn over

Answer **all** questions.

Section A

1 Fig. 1 shows a city tram and a close-up of the pneumatically operated sliding door.

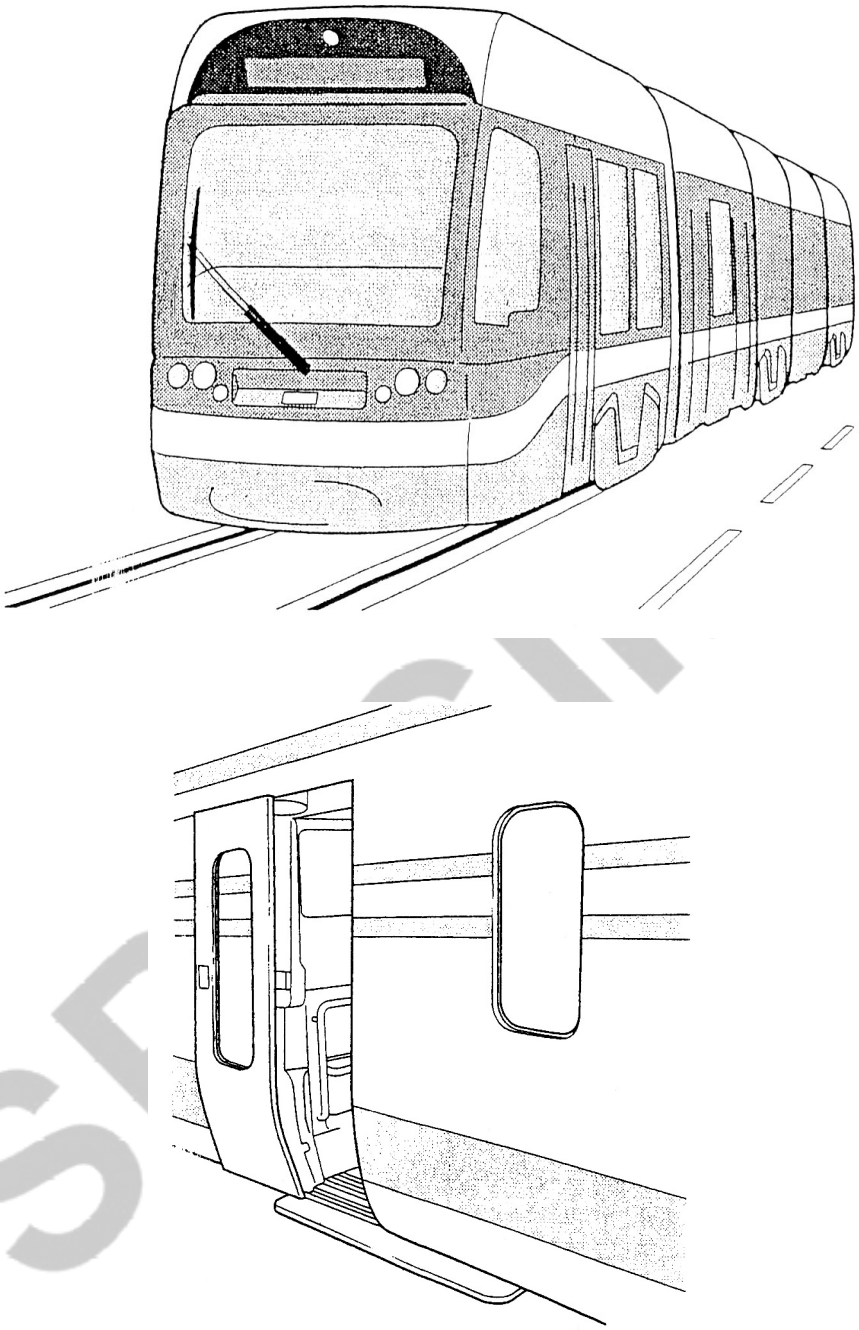
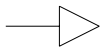
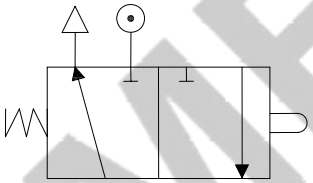


Fig. 1

(a) The table below shows the name and symbol for components in a pneumatically operated door system.

Complete the table by drawing the missing symbols and adding the missing names. The first one has been done for you.

Component Name	Component Symbol	
A exhaust		
B reservoir		**[1]**
C air supply		**[1]**
D single acting spring return cylinder		**[2]**
E		**[2]**
F shuttle valve		**[2]**

(b) Give **two** reasons for using a reservoir in a pneumatic system.

1. ..... **[1]**

2. ..... **[1]**

(c) Explain why component **F**, the shuttle valve, is often used in pneumatically operated tram door systems.

.....

.....

..... **[2]**

[Total: 12]

2 An incomplete circuit to control a pneumatically operated sliding door for a tram is shown in Fig. 2.

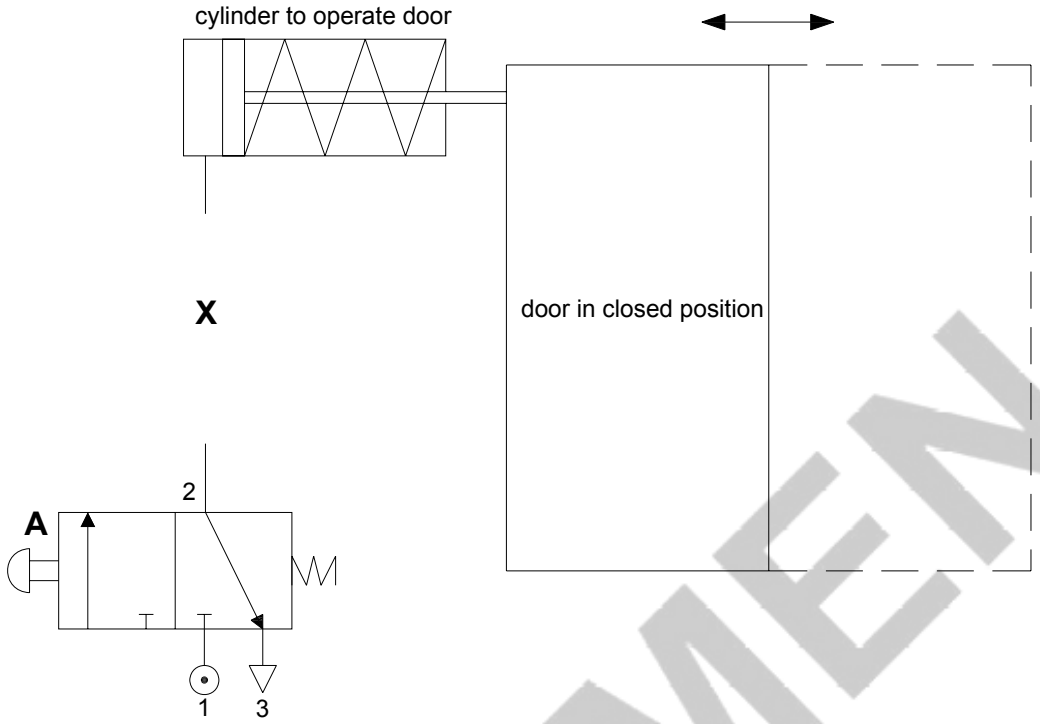


Fig. 2

(a)

(i) Complete the circuit shown in Fig. 2 by adding a uni-directional flow restrictor in position **X.**

The uni-directional flow restrictor should:

- make the door close slowly;
- make the door open quickly. **[3]**

(ii) Describe how the uni-directional flow restrictor works.

.....

.....

..... **[3]**

(b) The compressed air supply on the tram includes an air receiver (reservoir).
The air receiver is fitted with:

- a safety valve;
- a pressure regulator with a gauge;
- a drain valve.

Explain why the following components are essential to the safe operation of the system.

(i) Safety valve

.....

..... **[2]**

(ii) Pressure regulator with a gauge.

.....

..... **[2]**

(c)

(i) State the purpose of a drain valve.

..... **[1]**

(ii) Give one consequence of not making use of a drain valve.

..... **[1]**

[Total: 12]

3 Manufacturers of tram doors use computers to:

- aid the design process;
- test circuits
- control pneumatically operated manufacturing machines during the making of the doors.

(a) State **three** advantages of using CAD to draw circuit design layouts when designing a pneumatic circuit.

1. ..... **[1]**

2. ..... **[1]**

3. ..... **[1]**

(b) State **two** reasons for using computers to simulate the operation of a pneumatic circuit.

1. ..... **[1]**

2. ..... **[1]**

(c) A manufacturing company is considering changing its manually operated machines to CNC machines.

State **two** possible effects on the workforce.

1. ..... **[1]**

2. ..... **[1]**

(d) Computer controlled pneumatically operated manufacturing machines require a connection between the computer and the pneumatic circuit.

Fig. 3 shows the components that connect the computer to an incomplete pneumatic circuit.

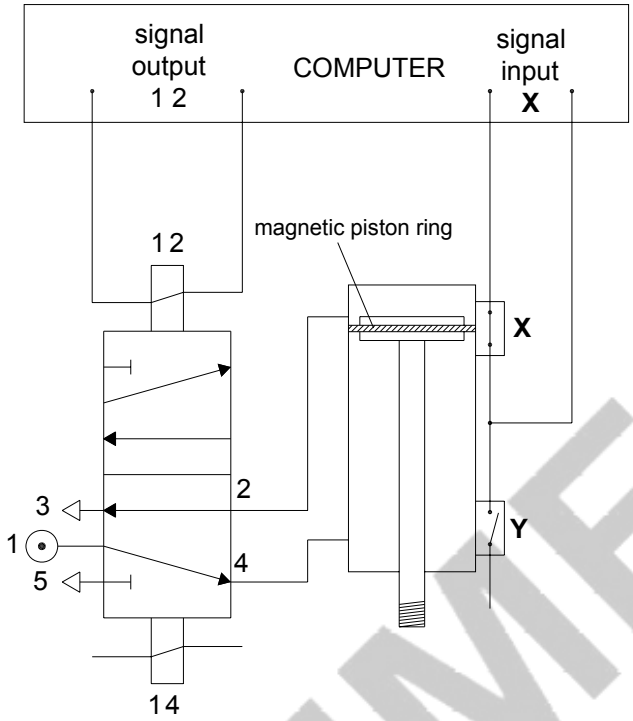


Fig. 3

(i) Sensors **X** and **Y** are reed switches that provide the input signal to the computer.

State how the sensors X and Y are triggered.

..... **[1]**

(ii) Describe what happens when the computer receives a signal that sensor **X** switch is closed.

.....

.....

..... **[2]**

(e) Give two benefits of the computer system for controlling movement of the piston compared to a mechanically controlled system.

1. .....

..... **[1]**

2. .....

..... **[1]**

[Total: 12]

Section B

4 During development of the sliding tram door a link mechanism was introduced to improve the effectiveness of the pneumatic cylinder.

Fig. 4 shows an arrangement for the cylinder and the link mechanism.

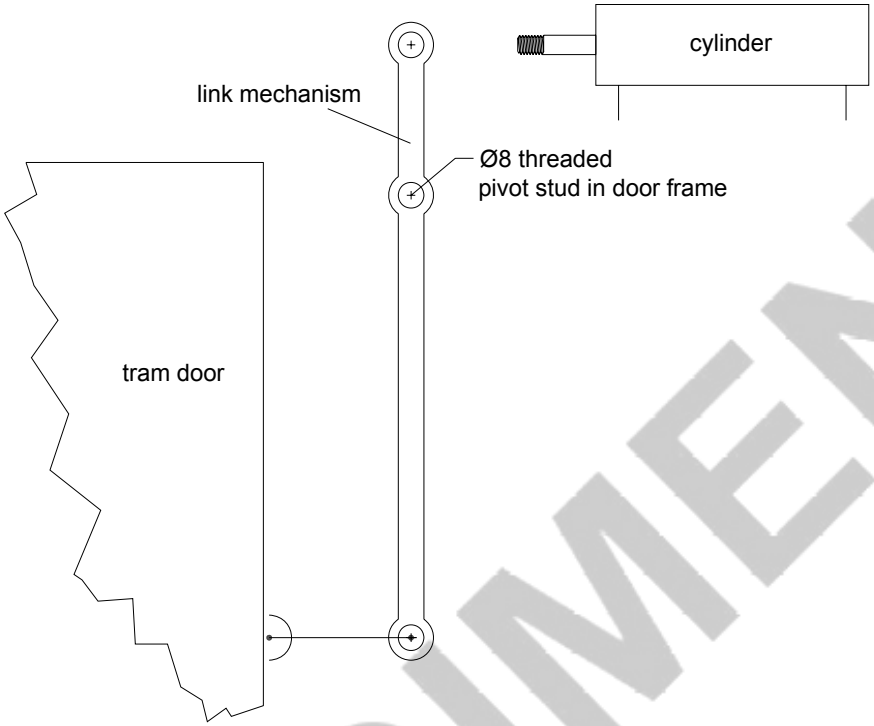


Fig. 4

(a) On Fig. 5 draw a design for a connector that will allow the M8 piston rod of the cylinder to be attached to the link mechanism.

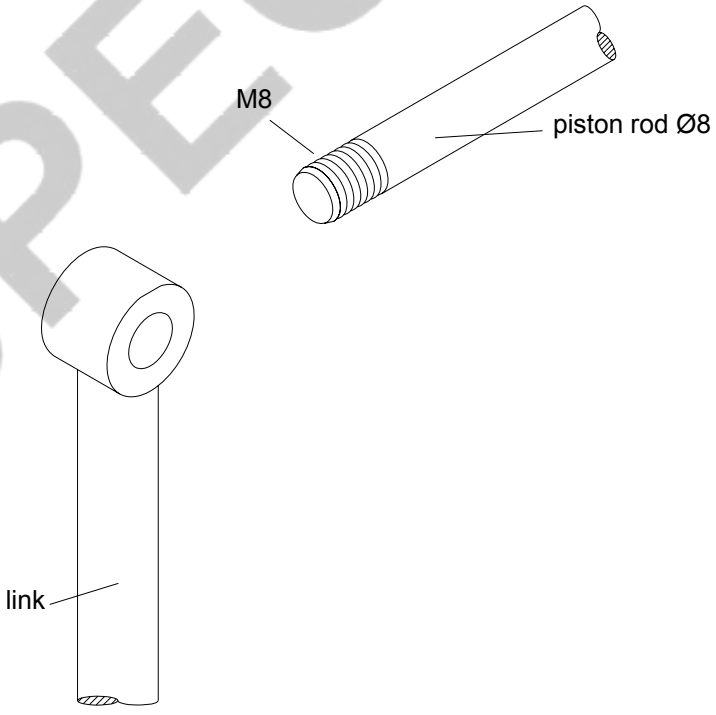


Fig. 5

[4]

(b) When the cylinder was connected to the link mechanism and bolted rigidly to the door frame the link mechanism moved very little. The door would not fully open or fully close.

Draw on Fig. 6 a modification to the top of the link mechanism to allow:

- the link mechanism to move in an arc;
- the cylinder to remain horizontal.

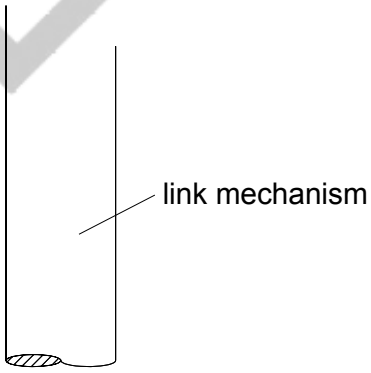


Fig. 6

[3]

(c) The tram door mechanism is subjected to a lot of vibration when in use.

State two locking devices that could be used to prevent the link mechanism coming off the threaded pivot stud in Fig. 4.

1. ..... **[1]**

2. ..... **[1]**

(d) Pneumatically operating sliding tram doors have a built-in safety system which will detect an obstruction.

One way of doing this is to use a diaphragm valve in a pressure decay sensing circuit as shown in Fig. 7.

This circuit will re-open a closing door if an obstruction is detected.

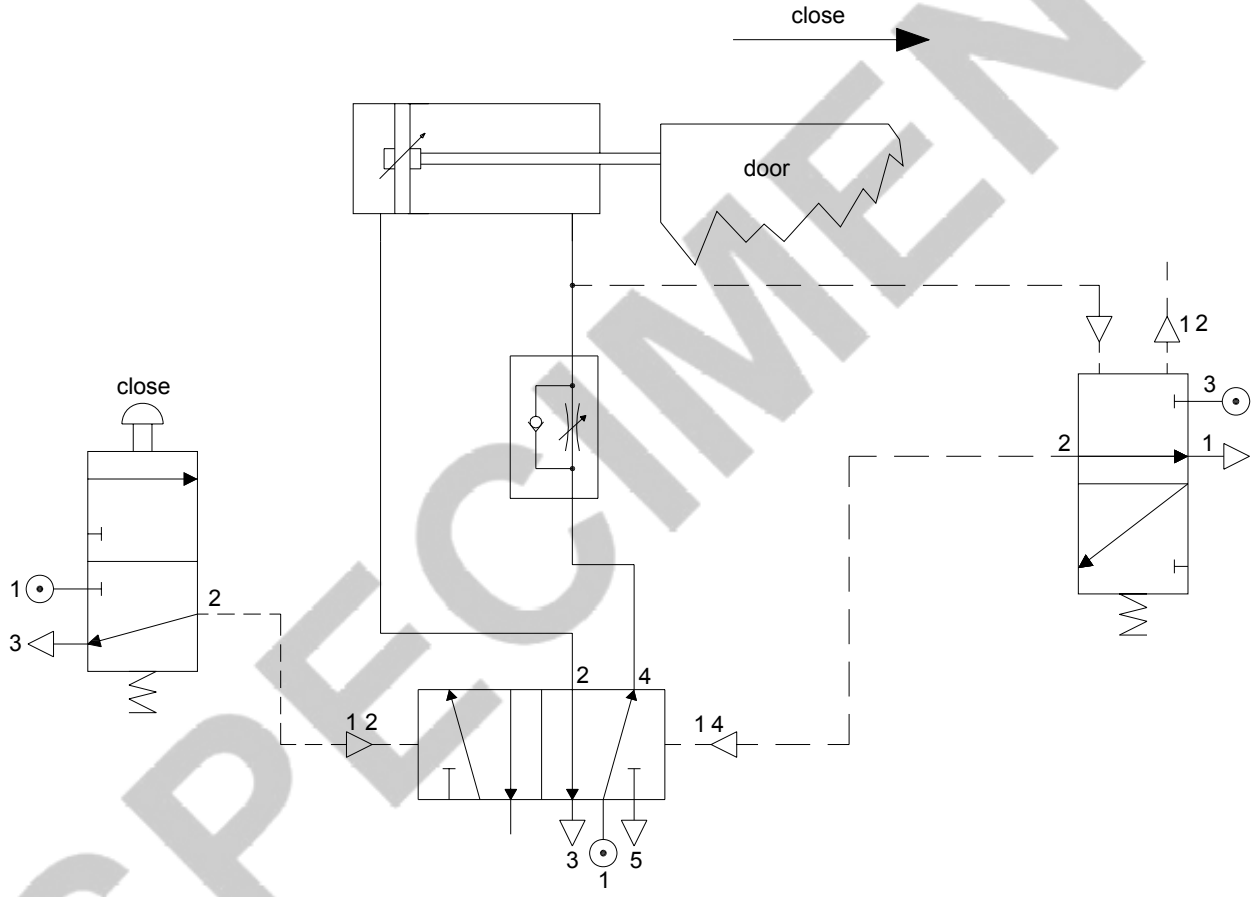


Fig. 7

Explain how the circuit in Fig. 7 works.

.....

.....

.....

..... **[3]**

[Total: 12]

5 A cylinder is required for the sliding door operation.

The cylinder chosen for this operation has a bore diameter of 32mm and a piston rod diameter of 10mm.

Tests show that a force of 100N is required to close the sliding door on the outstroke.

(a) Calculate the minimum air pressure supply required to close the door.

Use the formula F = P x A.

.....

.....

.....

.....

.....

..... **[4]**

(b) When the system was tested the door closed but when the 'open' button was pressed nothing happened.

The components and circuitry had been correctly connected.

Explain the reason for the door not opening on the **instroke**.

.....

.....

.....

..... **[3]**

(c) Describe how the problem could be solved without changing any of the components.

.....

..... **[1]**

(d) To prevent the tram moving before the doors are fully closed an air bleed occlusion circuit is installed.

The circuit uses a diaphragm operated spring return valve.

Complete Fig. 8 by drawing the diaphragm valve needed to send an air supply to the tram control when the door is closed.

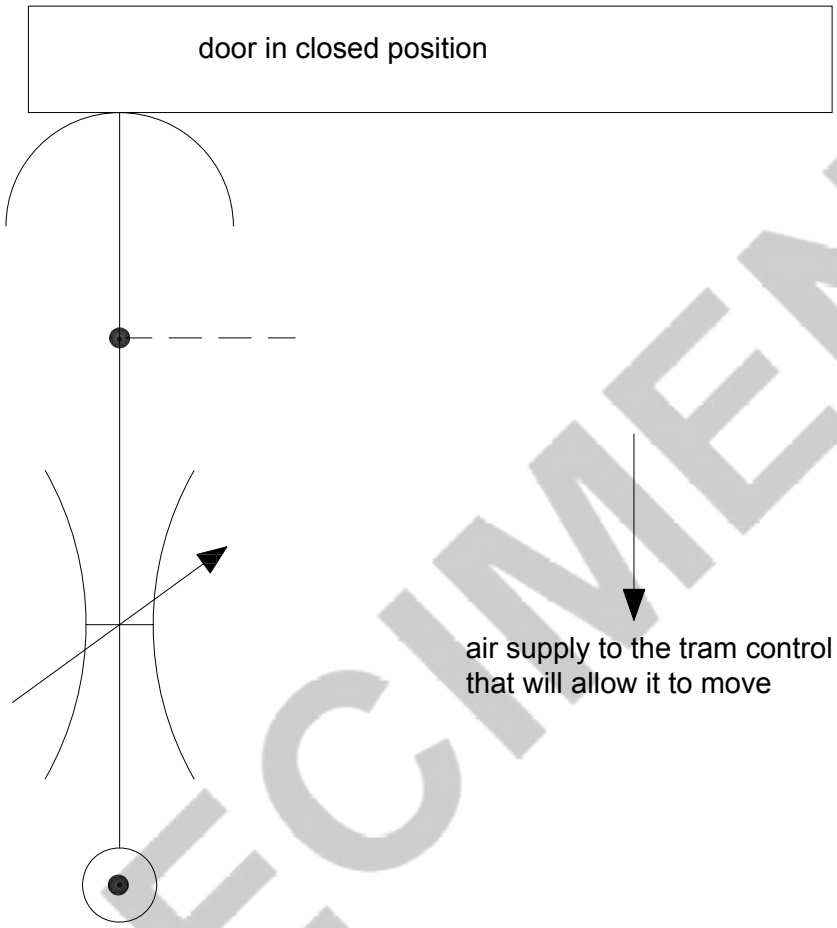


Fig. 8

[4]

[Total: 12]

Paper Total [60]

OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

General Certificate of Secondary Education

DESIGN & TECHNOLOGY A514/02

Control Systems: Pneumatics

Unit A514: Technical aspects of designing and making:

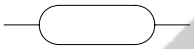
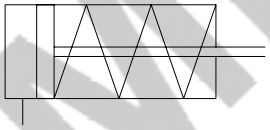
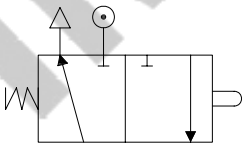
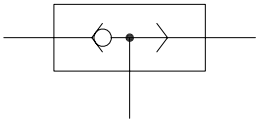
Specimen Mark Scheme

The maximum mark for this paper is 60.

This document consists of **9** printed pages.

Section A

Question Number	Answer	Max Mark
1(a)	**The table below shows the name and symbol for components in a pneumatically operated door system.** **Complete the table by drawing the missing symbols and adding the missing names.** **The first one has been done for you.**	

Component Name	Component Symbol
A exhaust	
B reservoir	
C air supply	
D single acting spring return cylinder	
E Plunger operated [1] 3/2 [1]	
F shuttle valve	

[1]

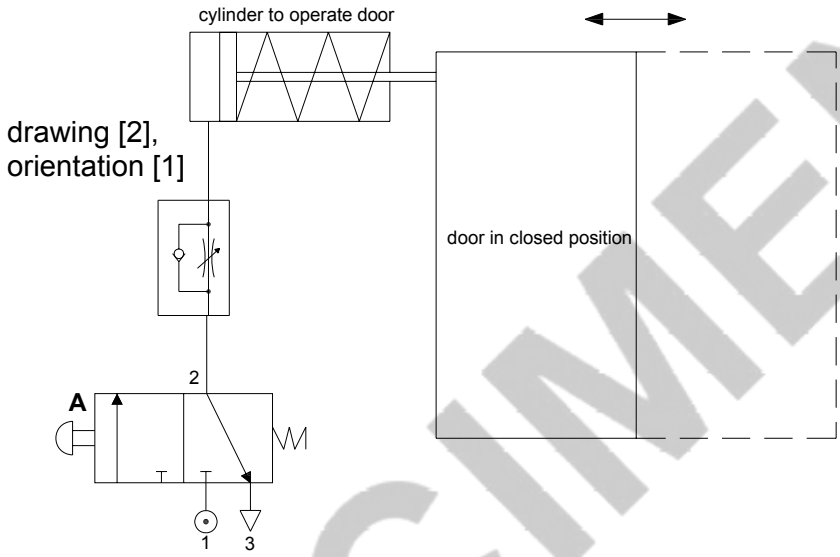
[1]

[2]

[2]

[8]

1(b)	**Give two reasons for using a reservoir in a pneumatic system.** The reservoir compensates for pressure fluctuations in the system, 1 markThe compressor does not need to run continuously, 1 mark Allow marks for understanding of each feature.	[2]
1(c)	**Explain why component F, the shuttle valve, is often used in pneumatically operated tram door systems.** Component B, the shuttle valve, is often included in sliding door systems because it allows the operation of the door from each side, 1 mark. It is an OR gate, 1 mark.	[2]

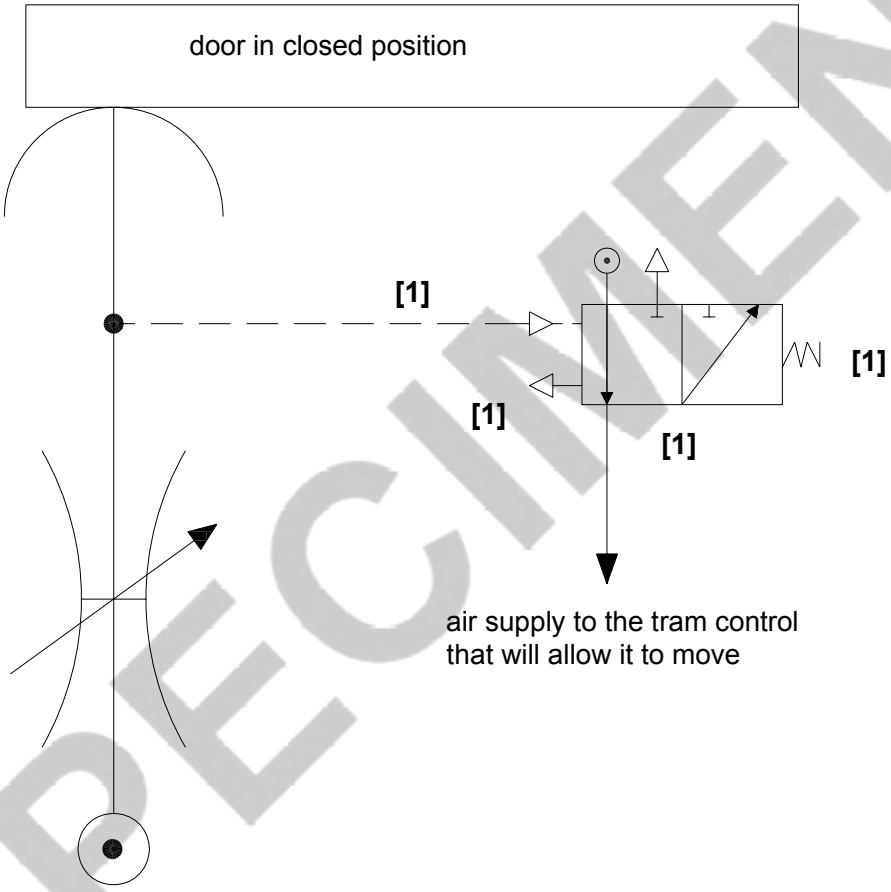
Section A		
Question Number	**Answer**	**Max Mark**
2(a)(i)	**Complete the circuit shown in Fig. 2 by adding a uni-directional flow restrictor in position X.** **The uni-directional flow restrictor should:** • **make the door close slowly;** • **make the door open quickly.**  	**[3]**
2(a)(ii)	**Describe how the uni-directional flow restrictor works.** A uni-directional restrictor works by allowing air to pass unrestricted through one way by blowing the ball away, 1 mark; but in the opposite direction the ball is blown into the socket, 1 mark; and the air must pass through the restrictor, 1 mark.	**[3]**
2(b)(i)	**The compressed air supply on the tram includes an air receiver (reservoir). The air receiver is fitted with:** • **a safety valve;** • **a pressure regulator with a gauge;** • **a drain valve.** **Explain why the following components are essential to the safe operation of the system.** **(i) Safety valve** The safety valve is an essential part of the compressed air system because if the compressor fails to shut off, and the pressure rises too high, it will release the pressure and prevent the receiver from exploding. 1 mark for problem identified, 1 mark for consequence identified.	**[2]**

Section A		
Question Number	**Answer**	**Max Mark**
(ii)	**Pressure regulator with a gauge.** The pressure regulator with valve allows the pressure to be regulated and displayed on a gauge. 1 mark for regulation, 1 mark for display.	**[2]**
2(c)(i)	**State the purpose of a drain valve.** The drain valve is used to remove condensation from the air supply system.	**[1]**
2(c)(ii)	**Give one consequence of not making use of a drain valve.** Possible damage to interior of receiver tank or other components in the system.	**[1]**
3(a)	**Manufacturers of tram doors use computers to:** • **aid the design process;** • **test circuits** • **control pneumatically operated manufacturing machines during the making of the doors.** **State three advantages of using CAD to draw circuit design layouts when designing a pneumatic circuit.** Advantages could include: • Accuracy of drawing; • Ability to copy and paste components; • Quicker to draws complex designs; • Easy to draw and save images; • Make changes to existing drawings easily. 3 x 1 marks.	**[3]**
3(b)	**State two reasons for using computers to simulate the operation of a pneumatic circuit.** • Reasons could include: • to help evaluate the integrity of the circuit; • to test the flow; • to test the viability of different components • to find problems and solve them through simulation. 2 x 1 marks.	**[2]**

Section A		
Question Number	**Answer**	**Max Mark**
3(c)	**A manufacturing company is considering changing its manually operated machines to CNC machines.** **State two possible effects on the workforce.** Possible effects could include: • Loss of workforce; • Need to retrain for new technology. 2 x 1 marks.	**[2]**
3(d)(i)	**Sensors X and Y are reed switches that provide the input signal to the computer.** **State how the sensors X and Y are triggered.** The switches are closed by the magnetic insert on the piston.	**[1]**
3(d)(ii)	**Describe what happens when the computer receives a signal that sensor X switch is closed.** When the computer receives a signal from X it then sends a signal to the 5/2 solenoid valve. 1 mark for signal from switch to computer, 1 mark for computer sending signal to valve.	**[2]**
3(e)	**Give two benefits of the computer system for controlling movement of the piston compared to a mechanically controlled system.** Benefits could include: • Ease of introducing delays to the system; • Ease of changing delays; • Lower cost than discrete components. 2 x 1 marks for suitable benefits.	**[2]**

Section B		
Question Number	**Answer**	**Max Mark**
4(a)	**On Fig. 5 draw a design for a connector that will allow the M8 piston rod of the cylinder to be attached to the link mechanism.** Connector should have: • Locknut [1] • Slot [1] • Pin [1] • Pin retaining [1]	**[4]**
4(b)	**When the cylinder was connected to the link mechanism and bolted rigidly to the door frame the link mechanism moved very little. The door would not fully open or fully close.** **Draw on Fig. 6 a modification to the top of the link mechanism to allow:** • **the link mechanism to move in an arc;** • **the cylinder to remain horizontal.** Modification should have: • Slot [1] • Wall thickness [1] • Washer / quality of drawing [1]	**[3]**
4(c)	**The tram door mechanism is subjected to a lot of vibration when in use.** **State two locking devices that could be used to prevent the link mechanism coming off the threaded pivot stud in Fig. 4.** Locking devices could include: • Nyloc nut / stiff nut / aero nut; • Split pin; • Castle nut; • Double nuts; • Loctite. Any two suitable methods 1 mark each.	**[2]**

Section B		
Question Number	**Answer**	**Max Mark**
4(d)	**Pneumatically operating sliding tram doors have a built-in safety system which will detect an obstruction.** **One way of doing this is to use a diaphragm valve in a pressure decay sensing circuit as shown in Fig. 7.** **This circuit will re-open a closing door if an obstruction is detected.** **Explain how the circuit in Fig. 7 works.** When the piston stops moving forward, the pressure in the exhaust line and pilot line to the diaphragm valve reduces, [1] When this happens the diaphragm will be reset by the spring. [1] This causes a pilot signal to be sent to the 5/2 valve. [1] This causes the direction of the air flow to the cylinder to be reversed. [1] Re-pressurising the pilot line then causes the valve to signal the piston to instroke.[1] 3 x 1 marks, allow any three correct.	**[3]**
5(a)	**Calculate the minimum air pressure supply required to close the door.** **Use the formula F = P x A.** F = P x A R = D / 2 = 32 / 2 = 16 [1] 100 = P x π x 16^2 [1] P = 100 / π x 16^2 [1] P = 0.12N/mm^2 [1]	**[4]**
5(b)	**When the system was tested the door closed but when the 'open' button was pressed nothing happened.** **The components and circuitry had been correctly connected.** **Explain the reason for the door not opening on the instroke.** The minimum pressure calculated was based on the full area of the piston. [1] On the instroke the area of the piston rod must be considered. [1] The result is less area for the pressure to act on. [1] Resulting in less force being produced. [1] Any three points correct for marks, 3 x 1.	**[3]**
5(c)	**Describe how the problem could be solved without changing any of the components.** Increase the air supply pressure.	**[1]**

Section B		
Question Number	**Answer**	**Max Mark**
5(d)	**To prevent the tram moving before the doors are fully closed an air bleed occlusion circuit is installed.** **The circuit uses a diaphragm operated spring return valve.** **Complete Fig. 8 by drawing the diaphragm valve needed to send an air supply to the tram control when the door is closed.**  	**[4]**
	Paper Total	**[x]**

Assessment Objectives Grid (includes QWC)

Question	AO1	AO2	AO3	Total
1(a)	8			**8**
1(b)	2			**2**
1(c)	2			**2**
2(a)	4		2	**6**
2(b)	4			**4**
2(c)	1		1	**2**
3(a)	3			**3**
3(b)	1		1	**2**
3(c)	1		1	**2**
3(d)	2		1	**3**
3(e)	2			**2**
4(a)	4			**4**
4(b)	3			**3**
4(c)	2			**2**
4(d)			3	**3**
5(a)	4			**4**
5(b)	3			**3**
5(c)	1			**1**
5(d)	4			**4**
Totals	**51**	**0**	**9**	**60**